REMARKS

The foregoing amendments in claims 1, 6, 10, 11, 14, 19, 23, and 24 are intended to define the invention more clearly to overcome the objections to claim 10, and the rejection of all these claims under Section 112, second paragraph, as indefinite.

The New Claims

Applicant has also added claims 27-35, including independent claims 27, 31 and 34, which define the invention with express reference to the various mathematical expressions, operations and relationships used in the specification.

The subject matter of new independent claim 27 is supported in the specification at page 23, line 1 to page 24, line 15; page 27, line 25 to page 25, line 16; page 28, line 10 to page 30, line 8; and page 38, lines 5-23. the terms appearing in claim 27 appear in equations 3-5 on page 23 applying the claimed method to R, G and B pixel values of of the original signal.

The subject matter of new claim 28, dependent from claim 27, relating to the parameter θ is supported in the specification at page 28, line 10 to page 30, line 8.

The subject matter of new claim 29, dependent from claim 27, is supported by the description of the invention appearing in the specification at page 28, line 9 to page 36, line 13.

The subject matter of new claim 30, dependent from claim 29, is supported in the specification at least at page 33, lines 1-6.

The subject matter of new independent claim 31 is supported by the descriptions in the specification at least at page 28, line 10 to page 30, line 8.

The subject matter of new claim 32, dependent from claim 31, is supported by the descriptions in the specification at page 24, line 25 to page 28, line 9 and page 30, line 9 to page 36, line 13.

The subject matter of new claim 33 dependent from claim 32 is supported by the descriptions in the specification at least at page 33, lines 1-6.

The subject matter of new independent claim 34 is supported by the descriptions in the specification at least at page 24, line 25 to page 28, line 9 and page 30, line 9 to page 36, line 13.

The subject matter of new claim 35 dependent from claim 34 is supported by the descriptions in the specification at least at page 33, lines 1-6.

The Invention as Claimed

The present invention provides a method for processing digital image data to control blurring of a digital image by sharpening the image. The process takes signal image data for each pixel, whether a gray scale value or values for red, green and blue chrominance signals, and processes that data. The process uses a function that defines a distribution of the image data obtained from the pixel-by-pixel image data. The process takes the value of a Laplacian (second order differential) of the distribution function, and subtracts it from the associated pixel value of the original image.

The invention uses a first parameter k that weighs (increases or decreases) the value of the second order differential so derived. The invention includes the use of set limit parameters θ,λ to control the amplification of noise and overshoot/undershoot, respectively, of the sharpening process. The Lapacian function of the present invention determines set values for the parameters k, θ, and λ by comparing the difference in the pixel values of a target pixel to the pixel values of adjacent pixels.

Turning to the specific comments of the Examiner, first, in response to the comments in part 1 of the Action regarding claim 10, claim 10 has been amended to add the work "method" as suggested by the Examiner.

With respect to the Section 112, second paragraph rejection of claim 1, and like rejections of independent claims 6, 10, 14, 19 and 23, the Examiner first questions the

phrase "obtained by defining the distribution of image data of the original images as a function, from the image data of the original image."

The present sharpening process operates on digital signal image data of an original image, not, for example, color image data that is first converted to gray scale values. The image data is a pixel value associated with a pixel. For RGB, there are three pixel values, one for each color.

The distribution of pixel values are defined as a function. The second Laplacian order differential of this function is subtracted from the pixel values. This is the known second-order Laplacian operation described on pages 3 and 4 of the specification, represented by equation 1 on page 4, and shown in Figs. 7(a) – 7(d).

The present invention changes this known second order sharpening operation by using a first parameter to weigh the Laplacian value that is subtracted from the pixel value of the original image. This is stated mathematically in equations 3-5 on page 23, with k representing the first parameter.

Moreover, as reflected in equation 2 on page 6, the Laplacian operation can be represented as the net differences between a target pixel value f(i,j) at the center pixel of a 3 x 3 matrix and the pixel values of the adjacent eight pixels f(i+1, j), f(i-1, j), ... This matrix representation is defined expressly in claim 6. Therefore, the second order differential "is obtained" by mathematically processing the image data and its distribution function. The independent claims have been amended to state this more clearly.

What is "being obtained" is the Laplacian (second order differential) ∇'^2. The sharpening process is that of adjusting the pixel values by subtracting this Laplacian pixel value for the associated pixel value of the original image, and controlling "the degree of sharpening" ... "by altering a first parameter."

With respect to the rejection based on lines 4-5 of claim 1, and like rejection of other independent claims, Applicants note that there is image data associated with each

pixel, e.g, the "original signal" **shown** in Figs. 7(a), 8(a) and 9(a) for a row of pixels. It is represented by "f(i,,j)"; exemplary image data values for these pixels appear in Tables 1 and 2 on pages 8 and 10 of the application.

The operation of this known Laplacian second order differential operation is **shown** in Figs. 7(b), 8(b) and 9(b). Exemplary values for "Laplacian B" are given in Tables 1 and 2. The "distribution" is the array of signal values of the multiple pixels.

As noted beginning at page 5, bottom, the Laplacian (e.g. of equation (1)) can be represented, using a 3 x 3 matrix of pixels with a target pixel at coordinates i,j in the center, in the form shown in equation (2) on pages 5 and 6. Therefore, the "second order differential" is defined in its conventional form equation (1) and its equivalent matrix representation form of equation (2). As stated at page 13, lines 13-19,

> "[t]he second-order differential is basically obtained by the sum total of differences between the pixel values of the target pixels and a plurality of pixels in the vicinity thereof. In the method of the present invention, each of the pixel values Is multiplied by a coefficient, and each coefficient is altered in accordance with the size of the corresponding difference."

In answer to the Examiner's second question, the second order differential is related to the distribution of an original image as a function (as shown in Figs. 7-9), and in the matrix pixel value representation discussed in connection with equation 2, Tables 1 and 2, as a function defined by one or more of equations 3-9.

The image data f(i,j) or $f_r(i,j)$, $f_g(i,j)$, $f_b(i,j)$ is associated with a pixel having coordinates i,j. The image data is not the pixel, but a pixel value for the image data associated with that pixel.

The Laplacian ∇'^2 of equations 3-5 according to the present invention is further defined by equations 6-9.

With respect to lines 6-9 of claim 1, the Examiner inquires as to the nature and functioning of "the first parameter." The first parameter is described as "k" in the specification. It is a value that weighs (increases or decreases) the value of the Laplacian (second-order differential) which, in turn, alters the image signal value to sharpen an image edge. The use of the first parameter to control the sharpening process is a significant aspect of the invention. The "size" or value of the second-order differential, so calculated, is subtracted from the image data for an associated pixel.

In claims 10, 11, 23 and 24, the term "and/or" has been deleted in favor of "at least one of" an upper and lower limit.

While the Examiner has not examined the claims on the merits, Applicants note that none of the prior art of record discloses a method for sharpening a digital image using a Laplacian sharpening process acting on original image (pixel) data where a first parameter k weighs the Laplacian pixel value subtracted from the original pixel value. k is not an identity. Further, none of the art of record discloses Applicant's second and third parameters to central noise amplification and overshoot or undershoot at an edge, which is characteristic of conventional Laplacian (second order) sharpening processes.

Applicants gratefully note that the formal drawings on file were accepted and the claim of priority under 35 USC 119 is acknowledged.

Applicants urge that given the foregoing amendments and remarks, the pending claims are definite, and they define novel, patentable subject matter over the art of record. This application is therefore believed to be in condition for allowance.

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Respectfully submitted,

By _____

Peter J. Manus
Registration No.: 26,766
EDWARDS & ANGELL, LLP
P.O. Box 55874
Boston, Massachusetts 02205
(617) 439-4444
Attorney for Applicants